Appendix A.5

Observing Site Precipitation Frequency Review Comments and Responses

June 27-July 26, 2002
Semiarid Southwest

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Introduction

This document is a consolidated summary of all the review comments with our response. The wording of the comments was unchanged to make sure the meaning was not misconstrued and so individual reviewers could identify their comments. We've noted those cases where we don't have an immediate resolution.

The majority of the comments pertained to the PFDS (32), however the solution to these are easy software changes/fixes. The most significant data-related issues include: unusual steps or changes in slope in the IDF curves, and significant differences between our results and storm events in some locations. Similar issues/comments were grouped together and are accompanied by a single response. The comments and their respective responses have been divided into seven categories:

1 **Internal consistency and step functions**
2 **General data**
3 **Comparison with NOAA Atlas 2 and other sources/storms**
4 **Precipitation frequency estimates too high/low**
5 **Methodology**
6 **PFDS**
7 **General/miscellaneous**

Summary

Review period: June 27 – July 26, 2002
Number of reviewers notified: ~84
Number of reviewers that responded: 25 (30%)
Number of unique comments: 74

1 Internal consistency and step functions

1.1 For the station data at Las Vegas WSO Airport (26-4436), the plot of All Season Precipitation Frequency Estimates and that shown in the All Season Precipitation Frequency table indicates that the 1000-yr, 6 and 12 hour values are greater than the 24 and 48 hour amounts. How can this be? Examination of the "Intensity-Duration Frequency" curves shows a rather smooth transition but one has to examine carefully the slope of the curves shown and one can see that there is a problem with the 1000-yr, 6 and 12 hr values being greater than the 24 and 48 hr values. How many other places this occurs at I am not sure but I suggest this problem be seriously looked into at other sites if it should occur there also.

The point rainfall depths for the 24-hr and 48-hr 1000-yr frequency at Las Vegas WSO are LESS THAN the 12-hr depth for the same frequency event. For a given frequency, I would

expect that the point rainfall depths would increase with longer duration events.

Viva Las Vegas. For the 1000 year rp, check Las Vegas at 6, 12, and 24 hours. rainfall goes down. Also a smaller decline from 12 to 24 hours for the 500 yr. Problems in extending curves? this is where some smoothing comes in?

Response: We are investigating this internal consistency issue (when 6 and 12 hour values are greater than 24 and 48 hour amounts), which occurs at more than one site but does not appear to be widespread. We do not currently know the cause. We will determine why this happens and how we can remedy it.

1.2 I looked at sites: Truckee RS (04-9043); Reno WSFO Airport (26-6779) "All Season Site-specific Precip. Freq. Estimates" plots and the information shown for the 2-year 5-min through 60-day duration curve looks great; however, that for return periods greater than the 10-yr look really odd (both internally; within the individual station data and when comparing both sets of data.) What is going on here? Do you have an explanation for why these curves don't look a bit more similar? I'd check this out for other locations.

Response: We are investigating these stations and will be checking all stations in the study area for similar problems. The results for Truckee RS clearly have a problem. The data for Reno WSFO Airport isn't as clearly flawed, and perhaps not flawed at all. The linear trend from 60-m to the 5,10,15 and 30-min durations is the result of a constant ratio to the 60-min estimate, thus probably okay.

1.3 At Truckee RS, I notice that the 1000-yr 12-hr precip value is 4.73 inches; yet the 1000-yr 12-hr incremental value for this station between the 12-hr and 24-hr 1000-yr depths indicates a magnitude of 4.9 inches. Is this possible? Something is wrong or I need an explanation as to why this is occurs.

Crystal Lake has another peculiarity in that for return periods between 10 and 200 years, the precipitation accumulation between 45 and 60 day periods is about 3 inches but for 500 years it is about 15 inches and for 1000 years it is about 19.5 inches.

Response: We are investigating any sharp differences or step-functions between sequential durations at all stations, between the 12 hour and 24 hour durations in particular. Any station with large differences between durations will be flagged and closely scrutinized to determine the cause and we will take appropriate action to resolve this problem globally or case by case. Currently we cannot say further how we will remedy this issue until we know the cause.

1.4 In a related matter, we examined the precipitation intensity tables at just one station—McNary 2N, AZ. We found that the 1000yr (0.28"/hr) intensity times the 24hr duration = 6.72", which was different from the published 1000yr/24hr precipitation value (6.83"). Are these two values supposed to be the same, or should they be different. Please explain.

Response: Yes, they should be the same, but the difference is the result of rounding. The highest resolution 1000y/24h estimate the PFDS has for McNary 2N is 173.48 mm (you can get this by selecting Metric units). That equates to an intensity of 7.228 mm/hr, or 0.2845"/hr, which rounds to 0.28"/hr. I suggest using the metric units for the highest precision data.

1.5 I am used to seeing sets of pf curves where the precipitation intensity (1st derivative of precipitation with respect to a fixed time interval) continually decreases with increasing duration. This means for example that the precipitation plotted at the 6 hour point is the greatest precipitation for a 6 hour interval in the pf curve for a particular return period, and so on for every duration in the curve. While the data for many stations that I checked approximate this criterion, there were several other stations I found in my somewhat random search where the data presented deviate significantly from this, some so much so that I don't really know how to interpret those particular station data sets. What follows are examples of what I found in a random sampling of 30 or so stations.

Las Vegas WSO AP,NV: at 500 and 1000 years, the 24 hour precip is less than the 12 hour precip.

Searchlight, NV: At 1000 yr, only 0.02" of precip accumulates between 6 and 12 hours, yet 3.57" accumulates between 12 and 24 hours.

Arroyo Seco Ranger Station, CA:
The accumulation rate between 30 and 45 days greater than the accumulation rate between 20 and 30 days at all return periods.

Laguna, NM: The accumulation rate between 12 and 24 hours is greater than the rate between 6 and 12 hours and the 7-10 day accumulation is greater than the 4-7 day accumulation.

El Centro 2SSW, CA: At 1000 yr, only 0.13" precip accumulates between 2 and 12 hours, yet 1.71" accumulates between 12 and 24 hr and 1.05" between 24 and 48 hr, then only 0.11" between 48 hr and 7 days.

Bosque del Apache, NM: At 1000yr, we have only 3.00" for the 12 hour value, yet 4.43 accumulates between 12 and 24 hrs. The 3 days between 24hr and 4 days show an accumulation of 0.16" yet between 4 and 7 days, 1.88" accumulates. the 38 day period between 7 and 45 days shows an accumulation of 0.41" yet 2.36 accumulates between 45 and 60 days.

The examples cited above seem to be what one would expect to see for a cumulative mass curve of precipitation at a particular location for an actual series of events over a 60 day period of climatological record interspersed by dry periods of varying lengths.

Response: We are carefully investigating these specific examples as well as all other stations. We are developing software to screen and test output for all stations that behave like this.

1.6 Below are problems I have found with Texas stations appearing on the New Mexico map. Many stations in the Pecos and Rio Grande river areas have too little increase in precipitation totals between 10 days and 20 days at very long return periods, presumably due to a relative overabundance of excessive 10-day events during the period of record. These stations include:
Red Bluff Dam
Wink Airport
Penwell
Monahans
Pecos
Buenavista

Mentone
Imperial
Kent
Grandfalls
Socorro
Salt Flat
La Tuna

Four stations have too little increase between both 10-20 and 20-30 days at very long return periods:
Toyah
Van Horn
Fort Hancock
Fabens

Several stations near the Pecos river have too little increase in precipitation totals between 24 hours and 48 hours at the shortest return periods:
Muleshoe NWF
Salt Flat
Pecos
Buenavista
Imperial (48 hr 2-yr totals are less than 24 hr 2-yr totals)
Mentone (little change between 1 and 4 days)

Several stations have an unrealistic jump in precipitation totals between 12 and 24 hours at long return periods:
Andrews
Imperial
Red Bluff Dam
Sierra Blanca
Fabens (24 hr 1000-yr total is more than double 12 hr 1000-yr total)

Fort Hancock rainfall totals seem too high compared to nearby similarly-situated stations (Tornillo, Fabens, Socorro, Ysleta)

Kent totals seem too low for accumulation periods below 10 days.

Plains has an unrealistic near-peak at 45 days.

Coldwater totals seem too low at and around 20 days.

Romero totals are too high for long return frequencies compared to surrounding stations (Dalhart, Bunker Hill, Nara Visa NM).

Response: We are investigating stations showing “unrealistic jumps in precipitation totals” and developing tools to screen the data for this. Your insights into whether our values are too high or low are valued, however we need data we can use to objectively alter our results. Eastern NM and TX are particularly difficult areas because of the lack of good quality observations with a long period of record and a sufficient spatial density.

2 General data

2.1 We assume that there are no data available below 24 hr duration at many stations because these are daily observation stations. Correct?

At a few locations we clicked on there were no data for longer than 24 hour duration (for example, Camp Angelus CA (041369). Why?

I note that many of the sites do not have 5-min to 12-hour data. I assume that this is because these are 24-hour gage stations. Additionally I find a number of locations that do not have 48-hour to 60-day data. Will this data be obtained from other sources in the final product? If so, will there be any notation on how the data was obtained.

I have one suggestion - Make it clear that some locations only have data for 24 hour or longer durations, while other have data available for shorter durations. It may confuse some customers if they see data for 6 hour, for example, for one location but not another.

On the graph for stations with only 24-hr data, it is not necessary to draw a line from the base up to the amount for the 24-hr duration. That line has no meaning.

Unless I missed something, I could not get subdaily estimates of precipitation frequency. Will this functionality be available?

Short duration (less than 24 hour) data was not provided for any stations within Maricopa County except for three stations (Phoenix WSO, Phoenix City and Painted Rock Dam). Painted Rock Dam only had short duration data, and no data was provided for durations greater than 24 hours. In the absence of short duration data, FCDMC cannot complete its review and will provide additional comments when all data becomes available.

Response: Stations that only had data for <24 hours are hourly stations, while those with >=24 hr data are daily stations. Once the complete spatial data is available for all durations/frequencies, there will be no gaps in the data. We are using PRISM based spatial interpolation techniques which will not only result is estimates between observing sites but also at observing sites in the cases noted in the opening sentence. An hourly station location will be populated with a complete series of data (out to 60-days), likewise the daily stations will be populated with data down to 5-minutes. In other words, in the future if you desire data for a specific station, it will be transparent whether it is an hourly or daily (or SNOTEL) station, but if you'd like to know more details about the station, our final report will contain station lists for this information. For a subset of stations, a software bug prevented the 48-hour to 60-day data from appearing. This particular issue has been resolved.

2.2 Did the short duration rainfall data we sent you get included in the Riverside County SW Arid Study?

Response: Most n-minute data is used indirectly due to the sparsity of n-minute stations. N-minute ratios were calculated from n-minute data. The ratios were used to convert 60-minute hourly values to shorter durations. We had neglected to sum n-minute stations and use the hourly and longer period sums directly. Your question has prompted us to do this.

2.3 The inclusion of confidence intervals is a much needed and appreciated addition. I would suggest that you also include the period and/or number of years of record used for the statistical analysis for each site.

Response: Yes, we will provide station information on all daily, hourly and n-minute stations used in our study including the record period and years of record. We would also note that the confidence interval itself gives a more objective measure of the reliability of the estimates than the period of record.

2.4 Results: Depth-Duration-Frequency (DDF) curves or tables and confidence intervals for individual rainfall gage stations, isopluvials for typical durations and frequencies. It looks like that most of the gage stations have DDF curves with 12-our or longer time durations only. The confidence intervals seem to be very high. For example, for the 100-year 24-hour rainfall depth, the 90% confidence intervals are 3.39-4.00 in, 3.31-4.20 in, 3.35-3.98 in, 3.52-4.46 in, and 3.29-3.96 in for gage stations Granite Reef Dam, Griggs 3W, Buckeye, Wittman 4SW, and Litchfield Park, respectively.

Response: The confidence intervals at each site were computed through Monte Carlo simulation based on the original data and their statistical characteristics (data length, L-moments statistics) for the fitted distribution at a reasonable confidence level (90% was used for the study). The number of repeated simulations was set to 1000, which is acceptable in terms of simulation convergence and accuracy. In a brief look at the period of record for these stations, we found Granite Reef Dam, Griggs 3W, Buckeye, Wittman 4SW, and Litchfield Park with 82, 40, 105, 37 and 83 years of data, respectively, so one wouldn't expect the confidence intervals to by "very high." However, the confidence interval is also a function of the variance in the recorded data. On the other hand, we are concerned that because confidence intervals are generally not provided with precipitation frequency estimates, the estimates have taken on a aura of precision that is unwarranted. We expect some initial surprise when users become aware of the objectively determined confidence intervals we have computed.

2.5 Is there really no longer term data for El Paso WSO?

Response: There is, in fact we have 54 years of usable data for El Paso WSO, for all durations, including >24 hr which didn't show up on the PFDS – but has been fully used in our study. The reason for it not appearing has been identified and the problem has been fixed.

2.6 It would be nice to go all the way to "365-day" durations. Such would show the continuity of concept, and include another valuable piece of information in compact form. To get annuals I have to go to PRISM maps on another site.

Response: From a design point of view a 365-day event has limited or no use. The estimates we provide are for storms of varying durations, not climate normals for those periods. The PRISM maps and National Climatic Data Center products are a much better source for this information.

2.7 For the Siverbell station (02-7915), is the elevation correct? Nothing aberrant in the data from it, but the stated elevation (2613) looks low from my understandings of the local topography. No I've not checked it on the quad sheets.

Response: he PFDS will be providing data for 30-second grid cells rather than explicit points.

The grid cell elevation is based on a DEM. The elevation for the grid cell containing Silverbell is 2613 feet. The NCDC records indicate the Silverbell gage at 2740 feet.

3 Comparison with NOAA Atlas 2 and other sources/storms

3.1 Because the local agencies require development to use the NOAA Atlas, they need to buy off on it. If they have doubts on its validity, they may hold private developers to a higher standard than in the past for example, increase NOAA depth by 20%.

Response: n our initial comparisons, the new estimates, as you'd expect, are coming in relatively close to NOAA Atlas 2. However, there are a number of areas that are going to change, and some substantially. We have a more extensive set of data to work with and a variety of more effective analytical techniques than those available when NOAA Atlas 2 was developed. The provision of confidence intervals will also provide new information on the reliability of the quantiles themselves.

3.2 It's difficult to comment without the benefit of good data to support our initial thought. However, most locations away from the Albuquerque metro area looked reasonable. Unfortunately, the only Albuquerque site we could access was Netherwood Park. To us, the values look rather low, and generally 10-15 percent lower than the 1973 NOAA atlas (which we thought was already on the low side). We don't have much to go by, except the experience of being here during a number of events in which sections of Albuquerque received 2-3 inches of rain in less than 12 hours. Some of our worst flash floods have involved amounts of 3 inches or more in less than 3 hours. Some fairly recent examples includes a 1961 case with 4.07 inches of rain in less than 12 hours, 1963 case of 3.25 inches in one hour, 1980 case of 5-6 inches in 12 hours, 1988 case of 4-6 inches in less than six hours. A lot of our problem is that some flash floods have occurred as a result of heavy rainfall at higher elevations of the city, or even areas outside the city (western slopes of the Sandia Mountains). Of course, any precipitation that falls along the western slopes of the peaks east of the city is going to make its way toward the Rio Grande...coming through the city in the process. Perhaps the data just do not exist to support calculations for other elevations of the city. The foothills station (ABFN5) is at my house, but we only have about 11+ years of published data for that site.

Based on data which the Clark County Regional Flood Control District (RFCD) has collected over the past 14 years, the point rainfall depths provided in the All Season Precipitation Frequency table for Las Vegas WSO Airport (and perhaps other sites) appear to underestimate rainfall depths for durations less than 6 hours. During a single rainfall event on July 8, 1999, six RFCD gages reported depths which exceeded the 2.12" 6-hr 100-yr depth presented in the Precipitation Frequency table mentioned above (see the attached Flood Event Report). According to that table, the rainfall depths at those gages exceeded the 200-yr return interval depths, and the depths at two of the gages approached or exceeded to 1000-yr return interval depths. Similar "extremely rare" rainfall depths were recorded for durations of 15-60 minutes during this and other rainfall events. I am not suggesting that rare events do not occur or should not be expected, but rather that they DO occur more frequently than your results would indicate.

A more comprehensive research of the FCDMC network of gages with 8 to 20 years of data close to the Phoenix WSO gage reveals that in the past few years, 40% of our gages have already recorded precipitation that has equaled or exceeded the 100-year return frequency at least once. The summary of severe rainfall events for FCDMC gages can also be viewed at the

following web site: http://156.42.96.39/alert/Rain/stormsdb.html. Our data indicates that NOAA 14 analysis may be severely under estimating short duration precipitation totals, possibly due to limited number of gages used.

In the limited time available, FCDMC researched a few flood reports from recent floodings in the Phoenix Metro area dating back to 1963 (less than 30 years). A plot of the rainfall totals for these few select storms vs. IDF curve for the Phoenix WSO (one of the only two stations with short duration data as per PFDS Web site) shows that all these storms were well above a 1000 year return interval (see attachment #5 and #6). Is this statistically significant and how can this be explained? The latest event on attachment 6 happened just two weeks ago, and was included as an example only. By no means this was considered an unusual event and yet plotted above the 100-year line.

Generally speaking, the rainfall depths were reduced from Atlas 2 and because of our short duration storms here in the semiarid southwest, I would find it more interesting to see the shorter duration short event data, which were not included in the review. I am concerned that they may be exceptionally lower yet and that concerns me because we see storm events with much higher rainfall depths than those shown on your PFDS tables for 100-year, 24-hour storm events.

Response: The short period of record is the most constraining factor in using the vast number of "new" rain gage networks. These networks are revealing extreme events that we'd expect and that are commonly confused as being directly comparable to our results. This is because our statistics are based on individual, non-moving rain gages. It is rare for any single location in an area to get a cloud burst during any given year, but it is very likely that somewhere in the area will receive a heavy rainfall from a cloud burst. Our results indicate rainfall estimates **for points**, not what nature can produce within an area. This means that 100-year storms are occurring all the time. If talking about the "24-hour 100-year event," this really means the maximum 24-hour point rainfall that has a 1% chance of being exceeded in any given year at a specific site. On the other hand, if we did a study that represented the Albuquerque (or Las Vegas or Phoenix) metro area as a "site", we'd end up pulling in all of the extreme rainfall events from the area, regardless of where and what gage the rain fell in, and end up with a much higher 24-hour 100-year precipitation estimates. This is much different than the 100-year 24-hour rainfall amounts for specific points, which we are publishing and that NOAA Atlas 2 indicate. The term "100-year storm" has a very precise meaning and definition which overtime has become more and more misinterpreted. Even with that said, it's alarming that the Phoenix network has measured rainfall amounts exceeding the 1000-year return period and we will investigate.

3.3 Comparison with NOAA Atlas 2. This is also a policy issue for local government agencies. Generally speaking, the rainfall depths are lower on the NOAA 14 than those on the NOAA Atlas 2 for the majority of Maricopa County. Specifically, two areas were compared: White Tanks and Spook Hill. The 100-year 24-hour rainfall used in the ADMP study of White Tanks was 4.03 in. while the NOAA 14 gives 3.77 in (Griggs 3W); the peak flows estimated by HEC-1 model are reduced by about 10%. The difference in Spook Hill ADMP is much smaller, both rainfall and runoff have about 3% reduction. However, we did examine selected locations throughout the five state area, and compared these values to the NOAA Atlas 2 values, as best we could. In some locations there are significant gradients, so this made the determination of the NOAA Atlas 2 value a bit difficult, since we did not have access to the Atlas 2 point data. We found some differences from the NOAA Atlas 2 values, with largest

ones at higher elevations and at the 100 year return level, as might be expected. In the San Bernardino Mtns. east of Los Angeles the new values are considerable smaller than the old ones, although exactly determining the value off of the NOAA Atlas 2 map was a bit difficult. At South Fork Cabin, for instance, the 100yr/24hr value is now 3 or more inches less than previously. In other locations the new values are higher, including more than 1.5" higher at Grant Grove in the central Sierra. An area of significant difference appears to be on the west slope of the Spring Mtns. west of Las Vegas, where Red Rock Canyon is a relatively new station (since 1977) that obviously was not included in NOAA Atlas 2 (NA2). The highest values (100yr/24hr) in these mountains was just 4.4" in NA2, but the value for Red Rock Canyon is now 6.15". Undoubtedly, when new maps are produced the spring mountain maximum will be even higher than this—perhaps 7 or 8". With data where there was none before, it seems likely the new values are correct.

Response: Knowing how hard it is to make point comparisons from NOAA Atlas 2, we used the NOAA Atlas 2 interface at "http://www.nws.noaa.gov/oh/hdsc/noaaatlas2.htm" to get estimates for South Fork Cabin, CA. It turns out the new NOAA new values are 3" (24%) HIGHER than NOAA Atlas 2 for 100yr24hr; 12.50" vs. 15.47". Other areas of the complex California mountains have shown decreases of this magnitude, but these difference are understandable given the lack of data during the NOAA Atlas 2 development. Just as you say; Red Rock Canyon, NV is a classic case of this. Based on your comment, we critically investigated the data at this station and deemed it accurate. As a result the Spring Mountains will have higher precipitation frequency estimates. Based on your comments about Maricopa County, along with other feedback from that county itself, we are carefully evaluating the NOAA Atlas 2 vs. Semiarid preicpitation frequency study differences there.

3.4 Both Phoenix and Safford AZ, at relatively lower elevations, saw their values drop. The 100yr/6hr value went down nearly an inch at Phoenix (3.2 to 2.3"). This is quite significant. We did not investigate whether such a drop was region-wide, even in the Phoenix area, but this should be done.

Response: The Flood Control District of Maricopa County, AZ did an comprehensive evaluation of the Phoenix area, so we have a lot of good feedback about this area to consider. When looking at the PHOENIX CITY, ARIZONA (02-6486) station, the plotted data looks well behaved, so initially we can't turn to bad data for explaining this drop. Perhaps the driving reason for this difference, particularly at the lower frequencies (<50-yr), can be explained by differences in the statistical procedure, but regardless we will look into this. Obviously we can't "cook the data," and there is a chance the values are lower.

3.5 It would be very useful to have a difference map constructed (New-NA2). Perhaps this has been done. You infer that you have done this, but we would be interested to see what your analysis has revealed. As you know, maps are a terrific quality control tool.

Response: We prepared such a map, but we explicitly chose not to distribute it. We are hoping that comments on the new estimates are based on their reasonableness rather than on whether they are changed or on how they were computed. The map we prepared is solely based on station data and not spatially interpolated data, the spatial representation of the differences is biased towards station density. In other words we used a 2-dimentional inverse distance weighting scheme to spatially distribute the 100yr24hr differences, but a more accurate approach would entail doing a spatial map calculation that uses the NOAA Atlas 2 100yr24hr grid and the updated 100yr24hr grid. At this stage the updated 100yr24hr grid is not

available.

3.6 We have no basis to take issue with any of the new values. Except for the differences noted above, most of the values that we have examined are well within the range of normal expectation and noise. It was a bit surprising to us that the values, in general, had changed so little. Again, when new spatial coverages are completed using PRISM, the more significant differences may appear, due to the ability of new technology and data to depict more of the small scale variabilities and topographic forcings that were not possible when NA2 was produced.

Response: If just looking at the 100yr24hr results, you are right; for the most part they have changed very little from NOAA Atlas 2, but that isn't to say some areas are seeing substantial differences. We've carefully investigated and substantiated the areas with significant 100yr24hr differences. For a number of reasons we expect differences, but most importantly we strongly believe the new estimates are more accurate than NOAA Atlas 2. Certainly the computer power, statistical estimation procedure (L-moments) and spatial interpolation schemes are much better than was available back in the 1960s and 1970s for NOAA Atlas 2 and we also have additional data to work with.

3.7 In general the 6 and 24 hour rp depths for the Tucson city area are eye-catching less that the values currently used by the City in its design manual. FYI I'll send that to you next in a separate email (below):

The following are the return period duration rainfall depths used for hydrologic design by the City of Tucson, and by default, for much of Pima County as well.

	--inches--	
rp(yr)	3hr	24hr
2	1.30	1.83
5	1.80	2.50
10	2.30	3.17
25	2.80	3.83
50	3.20	4.50
100	3.60	5.00
500	4.60	6.33

Response: It is not unusual to find differences between our estimates and those published by others. We expect to find these cases with our new data as well. Differences from a variety of sources including, data used in the study, quality control, whether annual maximum or partial duration results are being compared (they have different meanings but are often incorrectly compared), the statistical methods used for finding the distribution parameters, the distribution chosen, the nature and influence of regional considerations, and etc. These types of estimates are statistically expected values and the variability associated with them is not generally published. The confidence intervals we are providing should give a more objective representation of the variability. We are confident in our approach, however we are interested in any information you might have that would result in different estimates.

4 Precipitation frequency estimates too high/low

4.1 The frequency tables presented for the Logandale, NV and Overton, NV sites demonstrate the problem with statistical analysis of precipitation frequency analysis in the semi-arid Southwest. These two sites are less than 5 miles apart and are both located in a broad flat valley without any significant topographic features to distinguish between the two sites. And yet the point rainfall depths for short duration events (less than 12-hrs) for the 100-yr return interval storms vary by 32-63%, depending on the duration of the storm. If you look at the point depths for the 24-hr 100-yr event, the rainfall depths are 2.73" at Logandale, 2.16" at Overton, and 3.28" at Valley of Fire. Geographically, Overton is located between Logandale and Valley of Fire. I would guess that this large difference is due to differences in the period of record used for the analysis at these sites rather than a reflection of reality. I do not believe that the precipitation gradient between these sites is as steep as your statistics indicate.

Response: For Overton we have 38 and 29 years of data for the daily and hourly station respectively. For Logandale we have 24 and 23 years of record for the daily and hourly station respectively, substantially less than Overton. Valley of Fire is only a daily station with 28 years of data. You are probably right in your assessment, that the differences in these stations are partially related to their period of record. If taking the 100yr3hr as an example, the difference between the estimates at Overton and Logandale is 0.61" – a significant difference at this duration. From a quick assessment, it looks like although Overton has more data, its estimates seem too low. Valley of Fire has higher estimates, presumably due to more orographic factors associated with its location and higher elevation. We will investigate further.

4.2 Data Review Observations for Cochise County, Arizona. Many data readings are less than the 1973 (NOAA Atlas 2) readings. Nearly all of the sites do not have data for events less than the 24-hr frequency. The most useful precipitation frequencies are for the 1-hr, 2-hr, 3-hr, 6-hr, 12-hr and 24-hr storms. There are no data above the 5548-ft elevation, even though there are many areas around Cochise County that are above it. There seems to be remote areas that have many data sites (ie San Simon, Portal), while other locations don't have any data sites given (Ft Huachuca, Huachuca City, Elfrida) while there is only one data site for the Willcox/Northern Sulphur Springs Valley area, which has the most flooding events of all the local communities. Does this imply that for these areas without data readings, the isopluvials for the updated atlas will be interpolated?

Response: You have identified one of the difficulties with this region of the country, i.e., the lack of long term observations at sufficient spatial density. It is interesting to note that the sum of the actual catch area of all the rainfall gages in the U.S. is roughly equal to a tennis court – in others words we're all working with very small samples! The estimates for Cochise County, along with all other areas of the study domain, will be spatially interpolated at high resolution for all durations and frequencies. The spatial interpolation for Cochise County will be largely driven by the stations you noted, as well as other representative stations in nearby counties. And yes, isopluvials will be provided.

4.3 I have looked at a number of locations where the gages are in close proximity. In some cases the differences are minimal or can be easily explained by topographic features. But in other areas, the differences are substantial and more problematic. For example:
Netherwood Park, NM 2-y,24-h=1.13 and 100-y,24-hr=2.62
Albuquerque WSFO Airport, NM 2-y,24-hr=1.05 and 100-y,24-hr=2.22
(There are some old timers who say that the airport was located to be in an area with minimal weather problems, not too near the Rio Grand or too near the mountains... a zone of better

conditions)
Santa Fe, NM 2-y,5-m=0.25 and 100-y,5-m=0.69
Santa Fe 2, NM 2-y,5-m=0.22 and 100-y,5-m=0.60
Carlsbad FAA Airport,NM 2-y,24-h=1.99 and 100-y,24-hr=5.79
Carlsbad,NM 2-y,24-h=2.10 and 100-y,24-hr=6.11
Two Rivers Reservoir,NM 2-y,24-h=2.02 and 100-y,24-hr=5.88
Roswell WSO Airport,NM 2-y,24-h=1.84 and 100-y,24-hr=5.37
Roswell FAA ARPT,NM 2-y,24-h=1.98 and 100-y,24-hr=5.76 (I'm not sure where this third gage really is. If the word "APRT" means "airport" then the last two gages may be in nearly the same location.)
Roswell WSO Airport,NM 2-y,5-m=0.27 and 100-y,5-m=0.75
Roswell FAA ARPT,NM 2-y,5-m=0.37 and 100-y,5-m=1.01 (Wow!)
Clovis 3 SSW,NM 2-y,24-h=2.33 100-y,24-hr=6.26
Clovis 13 N,NM 2-y,24-h=2.07and 100-y,24-hr=5.54
Tucson WBO, AZ 2-y,24-h=1.63 and 100-y,24-hr=3.95
Tucson NWSO, AZ 2-y,24-h=1.54 and 100-y,24-hr=3.75
Tucson Camp Ave Exp Fm, AZ 2-y,24-h=1.55 and 100-y,24-hr=4.21
El Paso WSO Ap, TX 2-y,24-h=1.30 and 100-y,24-hr=3.18
Ysleta, TX 2-y,24-h=1.24 and 100-y,24-hr=4.29
Socorro, TX 2-y,24-h=1.27 and 100-y,24-hr=4.38

Response: Eastern NM is a particularly difficult area because of the lack of data. Hit and miss extreme rain storms (from thunderstorms) drive all of the short duration data, so we expect to have variability. The variability should be reflected in the associated confidence intervals. Our spatial mapping procedure mitigates the statistical variability when interpolating and at the same time allowing for topographic variability. We will evaluate and address your concerns from a spatial standpoint once we have the draft maps.

5 Methodology

Hosking and Wallis, 1997 describe regional frequency analysis using the method of L-moments. This approach, which stems from work in the early 1970s but which only began seeing full implementation in the 1990s, is now accepted as the state of the practice. The National Weather Service is using Hosking and Wallis, 1997 as its primary reference for the statistical method in its current studies. The method of L-moments (or linear combinations of probability weighted moments), provides great utility in choosing the most appropriate probability distribution function to describe the rainfall frequency distribution. It also provides tools for estimating the shape of the distribution and the uncertainty associated with the estimates, as well as tools for determining whether the data are likely to belong to similar climatic regimes. The so-called “regional approach” recognizes that different observing stations can be assembled into groupings of similar climatic regimes (regions). It takes advantage of the similarity by assuming that stations within similar regions have in common the shape (not scale) of their rainfall frequency distribution curves. This assumption allows estimation of the shape parameters from the combination of the data from all sites in a climatic region rather than from each site individually, vastly increasing the sample data set used in the estimate (reducing the sampling error).

Hosking, J. R. M., and Wallis, J. R. (1997) Regional frequency analysis, an approach based on L-moments. Cambridge University Press, Cambridge.

5.1 The precipitation frequency estimates for each site seem to come from the single site data. Do they include any adjustment for regional factors, nearby sites...or is this just the site data evaluated by the appropriate methodology. If that is what they are, this should be clarified. This may also reduce the applicability of any single site data in areas where information from multiple gages and topographic conditions should be applied to obtain an appropriate precipitation frequency.

Response: The data for all but 8 stations were computed using a regional approach; 8 stations were computed as "at-site" rather than using the regional approach because we believe that an at site approach for these 8 stations is more appropriate. For details, see the progress reports available on line at http://www.nws.noaa.gov/oh/hdsc/current-projects/project.html. A complete report of the methodology used will accompany the final data.

5.2 A concise summary of the methodology used to develop the data sets would be useful.

Methodology: L-Moments were used in the statistical analysis of the rainfall data series. One advantage over conventional statistical methods is that L-Moments are less influenced by extreme events. It seems to me that it is too late to evaluate the method itself now.

Obviously I couldn't review your data or your statistical methodology so I can't make any comment on those. But I am concerned that the statistical method disregards outliers and that is what the semiarid regions experience many times. Now on the other hand, I as a drainage engineer for developers would find it hard to defend designing for the outlier storm events but regardless, they happen.

Response: Since the focus of this review was the reasonableness of the point estimates themselves, the details of the methodology were intentionally not provided. Our methodology was evaluated, scrutinized and accepted by a team of experts last year. In frequency studies, the outliers appearing in a limited time series data play a very important role in estimation of quantiles, especially for estimating the rare events with probabilities such as 100-y, 500-y, 1000-y and up. In our QC processes we have paid great attention to outliers. However, the tough point is still how to reasonably determine the underlying frequency distribution when there are outliers in a finite data series. The method of L-moments we have used has been demonstrated in peer reviewed literature to be particularly adept at handling this situation when compared to other methods.

5.3 Spatial Distribution of Rainfall Gage Stations: Are there adequate gage stations for spatial interpolation?

Response: We believe that Oregon State University's PRISM (Parameter-elevation Regressions on independent Slopes Model) technology, will provide us much better spatial interpolations than would otherwise be available. Samples of the maps to review are forthcoming.

5.4 Software Used: Is the computer software used in the study good?

Response: As you might expect, there are a number of software programs utilized. We have tested the software and believe it is robust and free of defects. The core statistical computations are performed by a modified version of publicly available code developed by the Mathematical Science Dept., IBM Research Division: FORTRAN CODE WRITTEN FOR

INCLUSION IN IBM RESEARCH REPORT RC20525, 'FORTRAN ROUTINES FOR USE WITH THE METHOD OF L-MOMENTS, VERSION 3'

J. R. M. HOSKING
IBM RESEARCH DIVISION
T. J. WATSON RESEARCH CENTER
YORKTOWN HEIGHTS, NEW YORK 10598, U.S.A.

5.5 It is impossible for the Flood Control District to do a comprehensive review of the results without a report that explains the basis at which they were derived. Review of the progress reports alone is not sufficient, since final data and methodology may have changed ever since this project started. Additionally, a graphical representation of the differences between the NOAA Atlas 2 vs. NOAA 14 will greatly facilitate ones review. FCDMC has developed such maps for Maricopa County from the data provided at the PFDS (see attachments 1-4).

Response: We prepared such a map, but we explicitly chose not to distribute it. We are hoping that comments on the new estimates are based on their reasonableness rather than on whether they are changed or on how they were computed.

5.6 I presume there will be some "smoothing" and coordination of data within regions and to be consistent with adjacent stations etc?

Response: This is a key part of the regional approach we have used, and yes, these factors have been incorporated into the results.

6 PFDS

6.1 The borders of state maps should include latitude/longitude tick marks. That would help users position themselves in selecting points on the map other than climate stations.

Response: Nice suggestion. We will add tick marks in the final version. In addition, the lat/lon of the mouse pointer is shown as it pans across the map.

6.2 The vertical axes on the IDF and DDF curves displayed by the server should be relabeled. The vertical axis on IDF curves should be labeled "Precipitation Intensity," not "Precipitation." It might also be more clear if the vertical axis on DDF curves were labeled "Precipitation Depth" instead of "Precipitation."

Response: Good idea. We'll make those changes.

6.3 The ranges of durations for which IDF curves and DDF curves are displayed vary from one station to another. I understand that some stations are daily stations, some are hourly stations, etc., but it was initially surprising to be getting different types of results. It seems that HDSC has a choice to be made here: When a station is chosen, should results for only the durations greater than or equal to the measurement interval be displayed? Alternatively, should all durations be displayed, with spatial smoothing or interpolation used to "fill in" the durations shorter than the station measurement interval? Perhaps both options should be considered. How does this relate to the methods planned to be used for generation of estimates for arbitrary locations? What does a user do if he needs a 5-min intensity, but the station is a daily one? Whatever decisions are ultimately made here, it is imperative that it be made crystal clear to the

user what he or he is getting.

Response: We agree, this is confusing. When spatially interpolated data is prepared for all durations/frequencies, there will be no gaps in the data.

6.4 HDSC requested reviews for durations from 60-min to 60-days, but IDF and DDF curves displayed for many sites include durations as short as 5-min. I have some concerns about statistical methods for such short-duration data, and have communicated them to Geoff Bonnin.

Response: You're right… at one point we said reviewers would only see 60-min through 60-days, because we weren't sure we could pull off getting the n-min data ready…but the final review letter dated June 27, 2002, read "5-minute through 60-day.

6.5 Noticed on the "MAP" section "Tiger Map Server" that the legend indicates two different depictions of county lines. Not sure why this is so. Please check into it and delete one or the other or further explain.

Response: Initial indications are that this is a bug in the U.S. Census Bureau's Tiger Map Server software. We will do our best to circumvent their software so it appears correctly, but it may be something we can't fix without removing the entire small map altogether.

6.6 I will raise a concern that the server offers far too much in the way of options for deriving precipitation frequency values. I personally do not like a dual presentation of values for any given location. Given the vagarities of sampling and problems of finite record at a given rain gage, I favor regionalized estimates in all circumstances. I am concerned that a user will go searching for the site values that produce depths most "useful" if not applicable for their purposes. The great feature of showing only regionalized estimates is that both liberal and conservative designers have the same depth.

Response: Our estimates are computed at point observing locations using a regional approach that accounts for both at-site and regional characteristics. The estimates are then spatially interpolated to provide a high resolution spatial coverage. In other words we only provide a single estimate at each location.

6.7 I note that the fixed location (lat/long) function and the area estimate functions were not working, so I could not test out any consistency with the observing site data, or get any information away from observing sites. This has limited my review extensively.

Response: For purposes of the review the functionality of entering a fixed location (lat/lon) was not available. The only two ways to get observing site data were via the map (clicking on site) or selecting it some the pull-down list. When spatial interpolations are complete, the fixed location functionality will be available. The review focused on the point estimates at observing locations. Spatially interpolated estimates we're not provided in this review cycle. Neither were depth area reduction curves.

6.8 The plots of the graphs of the tables with no data should be improved in the final presentation so that the curves do not go down to zero at the end.

Response: Since the final estimates will include ALL durations (5-min through 60-day), ALL frequencies (2-yr through 1000-yr) and high resolution spatial interpolation, the graphs will be

completely populated with data and so this problem will disappear.

6.9 I believe that you should add a statement to your web-application indicating that the results of your study, while based on an expanded data set over what has been previously available, and the application of current statistical theory, are still limited by a relatively sparse amount of data; and the application of a higher standard of care by local regulatory agencies is prudent.

Response: Our final product will be marked with appropriate usage caveats and disclaimers and be accompanied with complete documentation.

6.10 It's unclear where the data reading station is located (ie street address/building location, etc). The location maps provided do not indicate major road names. The Station List is not friendly to retrieve. The chart only names the city, county, and/or country and you must continue to search for station data.

Response: For the protection and privacy of volunteer observers, and to avoid vandalism at automated observing locations, specific addresses are often confidential. Our final maps and grids will have a spatial resolution of 30 arc-seconds.

6.11 I had only one "hiccup" after first logging in. After looking at data for a station the State Button would not return me to the State Map. I clicked on the US Button and then returned to NM but only 1/3 of my screen was usable because I had 2 PFDS Screens. I had to logout and try again. This problem did not return.

Response: We will make sure the “back” and “return to…” buttons do no spawn windows inside of windows.

6.12 I used the links to USGS Maps and EPA Watershed Map. It was cumbersome to use the BACK button to return to the Precipitation Frequency Web Page.

Response: We’ll modify the behaviour to spawn new web browser sessions when users click on these links and leave the PFDS output page intact.

6.13 The tables and numbers are easy to read. We think this will be a very valuable interface. Printing values was no problem, and the location map that is shown with each table is useful. There will still be need for some people to print maps. Of course, when the PRISM coverages are finished, pulling these into GIS will hopefully be easy to do, for conducting watershed studies, etc. This functionality with the gridded coverages must be provided.

Response: Absolutely, all of the ASCII GIS grids will be made available via a Spatial (GIS) Download web page on the PFDS. They will also be accessible via anonymous ftp. FGDC-compliant metadata will accompany the maps, as well as brief directions for downloading/importing the grids into a GIS.

6.14 It sometimes takes quite awhile for the “hand” to appear over a station location. It was faster to use the pull down menu on the right, but often we wanted to know the station name in a given location, without knowing ahead of time what it was.

Response: We apologize for this wait. The wait time is a function of Internet traffic. The state-specific web pages are rather large because they contain the coordinates for all of the

displayed observing sites. We don't think there isn't a lot we can do about this.

6.15 In one visit we clicked on Goldstone Echo 2 CA, and the tables for a station in Wyoming were given.

Response: This indicates a hole in the error trapping. This also tells me that a station was not selected and a default location in Wyoming is chosen. Data for Goldstone Echo 2 CA does exist and was accessible during my tests. We will add code to prevent this from happening.

6.16 Is it possible to just show the stations in the state that is selected off the map, rather than always list all stations for all states in the box at the right?

Response: Yes, and this change will not only occur based on your feedback, but by shear necessity. As we publish more data the station list will obviously become too big and cumbersome to use effectively.

6.17 There are stations in states outside the Semiarid domain (TX, OK, CO, WY, ID, OR, coastal CA) that are included in the pull down menu, and their data tables and graphs do appear if selected. However, if we click on one of those states (like WY) and request data these stations do not show up there, and we are given a message that no data for that state are yet available. Can this be changed?

Response: This could be changed, but stations in these areas are outside of the study domain and therefore will not appear in the final results. Although from a review standpoint we encouraged feedback regarding these stations, their purpose is to provide a smooth spatial transition across state boundaries. From this point forward, the data from these outer areas will only be used internally.

6.18 Just to be grammatically correct, data <u>are</u> always plural. Thus, it should be "Data are preliminary" in the heading, not "Data is."

Response: Thank you, we will make that change.

6.19 Will the information with the future fixed location (lat/long) data entry agree with the numbers obtained with the selected site information? Or will there be two sets of data that don't agree.

Response: The spatial interpolation scheme (PRISM) we are using is faithful to the observing site data so the datasets will agree.

6.20 The most useful parts for me to see are the all season frequency tables, the frequency graph, and the two location maps. The +/- 90 percent tables will be of interest to a few, but I suspect most users won't regulate based in the +/- 90 percent values. That means that page 1 and 3 will be often printed. Page 2 less often. But sometimes the formatting for printing is different... when there is no data for longer than 24 hours, the frequency table takes all of one page. The graph goes to page 2, and the maps to pages 3 and 4. This can be fixed and made more efficient.

Response: Good point. We will consider re-organizing the output pages to make them more print friendly. However we are also hoping that the provision of the confidence interval data

will provide a greater insight into the “real” accuracy of the estimates.

6.21 The latitude and longitude values on the two maps only display and print out the top 80% of the numbers. You can usually figure it out, but it looks bad.

Response: Unfortunately this is a bug in the U.S. Census Tiger Mapping software and out of our control to fix/change. I know it looks bad, but it’s better than nothing. {We should take responsibility for everything we provide!}

6.22 The state maps are sometimes pretty small, when trying to select a specific location. Consider a zoom in feature, perhaps by county or a zoom area. This would also help with point selection, which is sometimes difficult.

Response: This would be an excellent feature to add, but since the PFDS does not have the functionality of an Internet Map Server (IMS), such a change would require resources beyond those available. Once data is available at all locations, this may become less of an issue because you’ll have the liberty of picking a location (whether its at an observing site or not) with the mouse or by entering a long/lat.

6.23 It would be nice if the individual state pages and data display pages could be made to fit in a 1024x768 window without having to scroll left to right, perhaps by making the dark blue frame on the left compressible or narrower.

Response: Agree. We will make this change.

6.24 I missed the 'submit' button until someone pointed it out to me - perhaps one could be placed next to or just below each line where submit is appropriate.

Response: This has been reported by others as well. We will make this change.

6.25 Under "Climate Data Sources", the user has the ability of listing all gages within 30 minutes or 1 degree. However, when the data are listed, it is unclear what the group of gages represents. Presumably it is not the gages on which the study is based; many of them have periods of record far shorter than the 40-year criterion. It is not a comprehensive group of coverage; Maricopa County alone has more than 240 gage sites. Please clarify and consider adding additional gages to the database or links to local agencies so the user has a more accurate picture of available data.

Response: You’ve made a good point and we will clarify that the station lists one receives via NCDC’s web site are NOT necessarily the stations used in this study. However this is were the vast majority of our data came from and therefore we provide a link to that data source. A complete station list – along with dots on the base state maps -- will be made available for the final product. Due to severely limited data (both spatially and temporally) in the Semiarid Southwest, we used a 20-year period of record criterion for selecting stations to be used.

6.26 FCDMC requests that the final NOAA 14 isopluvial maps also be provided in GIS format.

Response: 30-sec grids will definitely be provided for all statistics as well as isopluvial maps (in a GIS format such as shapefile).

6.27 The type of gage at each site is not indicated, e.g., SNOTEL, weighing type rain gage, tipping bucket rain gage, other types, etc. On your colored state maps showing rain gage locations, you might use different symbols or colors to indicate station type.

Response: Your suggestion of adding the station locations and types to the colored state maps is one we will implement However, our delineation of gage types will be: hourly, daily, SNOTEL or other (Mesonets, etc). More detailed gage information (i.e weighing type rain gage, tipping bucket rain gage, should be obtained from NCDC). Distinguishing the type of station on the output page will not be necessary once the maps are complete because the underlying maps will represent data from all sources.

6.28 The period-of-record used for each study site, e.g., number of years of record, period of record, etc.

Would like to see the years of record shown for the stations used (hourly and daily).

Response: We assume your desire to have this information is to gage the reliability of the estimates. Instead of displaying the period of record (or data years), we're providing the confidence limits, which are a much better assessment of the reliability.

6.29 I know it is apparent that -9.99 means no data for a given duration. However, all the 9s clutter up the tables. Either a blank or a dash - would be acceptable.

Response: Once the underlying maps are complete, the data in the tables and graphs will be completely populated for all locations. This problem will dissappear in the final deliverable.

6.30 At certain wet stations in California, precipitation at longer durations and return periods can exceed 100 inches but the data tables and plots can't handle this. An example of this is Strawberry Valley,CA Another example is Crystal Lake FC 283-C,CA.

For any stations that have >100" precipitation in the tables the leading "1" is lopped off the value in the table (example 107.66 is shown as 7.66"). Surprisingly, this is then translated into the graphs, as well (graph of Camp Angelus drops from near 100 inches to just over 7" going up to 1000 yr return period).

Response: This is a formatting error in the software which will be fixed.

6.31 When I did the page printouts... it would be nice to have the station name on each page somewhere, however small. If I floor-sorted the pile it would be a mess to re-connect. As it was I found myself doing flip-backs anyway.

Response: Excellent idea. We will try to address this.

6.32 The map locating showing the Campbell Avenue Farm (02-0796) seems to have the red dot in the wrong place. close but no cigar. It should be south of the Rillito River. On my map printout, about a quarter inch south of the shown red dot.

Response: The red dots on the maps show the exact location of the rain gage, and this may or may not be directly within the town which the station is named after. In this particular case I

can't find 02-0796!?

7 General/Miscellaneous

7.1 I would also like to see relevant reports from recent authors on precipitation frequency since TP-40 and HYDRO-35 referenced. A subordinate section for each state would a nice location to show these. This is especially true for Washington, Montana, Oklahoma, and Texas since you all do not appear to be serving updated information for these states. Just a thought, but your server makes a good location for serving broader information regarding rainfall frequency values available from outside NOAA sources.

-- Schaefer, M.G., 1993, Dam safety guidelines, Technical note 3—Design storm construction: Olympia, Washington State Department of Ecology, Dam Safety Section, [variously paged].
-- Parrett, C.P., 1997, Regional analysis of annual precipitation maxima in Montana: U.S. Geological Survey Water Resources Investigations Report 97-4004, 51 p.
--Asquith, W.H., 1998, Depth-duration frequency of precipitation for Texas: U.S. Geological Survey Water Resources Investigations Report 98-4044, 107p.
--Tortorelli, R.L., Rea, A., Asquith, W.H., 2000, Depth-duration frequency of precipitation for Oklahoma: U.S. Geological Survey Water Resources Investigations Report 99-4232, 113 p.

Response: That is a good idea, but if we list relevant reports it would imply we endorse them and we can't do that.

7.2 I anticipate the much of this data will have legal standing in court cases and official reports. The problem with any WWW site is that it can be changed over time, sometimes without any indication of the change or official date of publication. A data of publication is important... even for a web site. Additional reference information as a reference document is also essential. The information produced by Netscape or Explorer at the top or bottom of the page is not enough.

I agree with your decision to publish the results of your study in PDF format on the internet. In the past we usually published only a few hundred or thousand copies of hydromet reports. For many studies, we soon ran out, which ran up our reproduction costs. The only problem you will have will be maintenance of the website.

All along, there was discussion about how to publish the document. Traditional hard copy, or CD. Has this been abandoned to go with the web site only? I hope not!

Response: We're glad you concur with our plans to publish the new estimates on the web. Although this presents regulators with a more virtual source for precipitation frequency standards, we will assure online documents/data are stable, constant, referenceable and accessible. The PFDS and its accompanying web pages will be maintained and a point-of-contact will be made available for future inquires. {Tye, we probably should embed a version number or date of some type in each product we produce whether it be a grid, web page or pdf}

7.3 Rainfall Data: Both the amount and quality of the rainfall time series are important, such as the length of the time series, number of outliers and missing data, and how they are dealt with. Should the data collected by FCD be included into the database?

Response: Most of these details will be provided in the final documentation.

7.4 A didn't find any of the data that USGS in Albuquerque sent to you for the Albuquerque area. This was several years ago. Now there is much more data available in computer format. (see Jack Veenhuis, veenhuis@usgs.com). AMAFCA and USGS spent some considerable money to get this data into a format that NWS could use and now it is used for.....nothing? I also understand that Maricopa County and Pima County in Arizona now have Alert data that has been collected for many years. I didn't find anything that looked like that data.

Response: Thank you for the follow up contact for this data. We will investigate this and be contacting Jack Veenhuis. There is even potential in using this dataset as part of our Depth-Area-Duration study.

7.5 Back when this project started, a large number of local government agencies contributed public funds to NWS to get the arid west project started. Some of these agencies seem to be on the e-mail list, but others are not. As things go forward, now would be a good time to keep them informed.

The data provided by NOAA 14 will be used by various agencies and others, and will become the basis for the design of infrastructure in the years to come. It is imperative that the review process be open to ALL agencies and parties who will be affected by this study, and that they should be given ample time for their review.

Response: We would greatly appreciate help from people like you, to make sure we have the appropriate people on our mailing list.

7.6 Somewhere it should be made clear that 1000-yr values really represent a probability of 0.001 based on your frequency analyses. If we truly are experiencing climate change, the 1000-yr values may have little meaning.

Response: Good idea. The true meaning and definition of precipitation frequency estimates is often misconstrued.

7.7 Have you found any evidence that metropolitan areas such as Salt Lake City, Phoenix, Tucson, and Las Vegas, have any effect on precipitation intensities in their areas?

Response: We haven't explored the effect of urban areas on precipitation intensities specifically. As you probably already know, a number of papers have focused on the effects of precipitation (in general) down-wind of urban areas.

7.8 Is there a significant relationship between rainfall intensities and mean precipitation (MAP)? Or, have you not looked at MAP for the stations in the study area?

Response: There is a significant relationship between the mean annual maximum precipitation and MAP. In fact, it is so strong that MAP spatial patterns are being used in spatially interpolating the precipitation frequency estimates.

7.9 Are there any plans to extend the study area in the western United States?

Response: The National Weather Service receives no funds from Congress for these studies.

We have performed them for over 50 years on a reimbursable basis using funds from other interested parties. Several parties have shown great interest in initiating a nation-wide study, however funds have not been forthcoming.

7.10 At the time of the publication of that Atlas (1973), I was the Science Advisor in the Office of Hydrology. Unfortunately, we did a poor job of drawing the rainfall intensity-duration-frequency lines for much of the west. I was interested in your comments on spatial interpolation in your Twenty-first Progress Report concerning the SCAS, Oregon State University, use of a program called PRISM. Although I am not familiar with that program, I assume it does a better job than we did. Assuming a linear relationship of precipitation intensity increasing with elevation and not considering exposure, etc., can produce excessive values.

Response: These issues will be come important during the review of the spatial interpolation. Your point about exaggerated extrapolation is one that many feared, but in initial tests, PRISM is doing a nice job of handling the situation. The use of SNOTEL data also provides a constraint at higher elevations. To learn more about PRISM visit this web page: http://www.ocs.orst.edu/prism/gen_toc.html.

7.11 Although seven of twelve study areas being used in the DAD studies are in the central or eastern United States, an area subject primarily to frontal and cyclonic-type precipitation, the desert --southwest is occasionally subjected to heavy rainfall from tropical systems augmented by orographic controls. You may find the twelve study areas produce similar DAD results.

Response: We are engaged in a national DAD update study, which will contain study areas from all areas of the US, including for example Walnut Gulch, Arizona. For more information, visit the Semiarid Precipitation Frequency progress reports at: http://www.nws.noaa.gov/oh/hdsc/current-projects/project.html

7.12 Maps, maps, MAPS... The point data is useful, but so are the traditional maps. So far, there is no way to see maps.

Loved the site and access to Atlas 2 and the rest of the data and publications. What's the future on relapsing to the public and additional data massaging and presentation? Like the smoothings, if there is to be any. Or will it remain in it's current "raw" form? Will there be maps with iso-lines eventually?

Response: There will be 162 different maps and GIS grids available from the PFDS when the Semiarid project is complete.

7.13 Are there independent statements on the effects of elevation in short distances? We have alot of that in Arizona. A local legend/folklore is that there is no effect to the top of Mt Lemmon: elev 9000 ft in back of town. At least no adjustments made in city and county design at last check. A noticeable relationship does emerge from the 16 stations I down-printed, Includes the Kitt Peak station at 6718ft.

Response: The effect of elevation will become apparent when you see the spatial interpolations.

7.14 Do you know of the prior paper on short duration rainfall in Arizona by Paul Kangieser? Out of Salt Lake City ca 1967 or so. operates from Atlas 2, which apparently gives partial duration information. Thus my prior query about annual series from the current site pages. Would be interested in your understandings on the relevance and applicability of it. Also, a similar paper by Arlo Richardson some years following about Utah short duration rp depths.

Response: We are not familiar with those papers. The results we provided for review are based on annual maximum series. Our final product will include conversions to partial duration series.